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SIR JOSEPH LARMOR AND MODERN MATHEMATICAL PHYSICS

By Professor GEORGE D. BIRKHOFF

HARVARD UNIVERSITY

SIR JOSEPH LARMOR, MATHEMATICAL PHYSICIST

ON May 19th last the scientific world lost a notable mathematical physicist, Sir Joseph Larmor, Lucasian professor of mathematics at Cambridge, England, from 1903 to 1932, successor to Sir George Stokes in this celebrated chair once held by Sir Isaac Newton. After being graduated from Queen's College, Belfast, Larmor took highest honors in the Cambridge Mathematical Tripos of 1880 at about 23 years of age, J. J. Thomson being second wrangler in the same year. Larmor was called at once as professor of natural philosophy to Queen's College, Galway, where he remained until 1895. He then returned to St. John's College, Cambridge, as lecturer, and was named for the Lucasian professorship in 1903. From 1901 to 1912 he was secretary of the Royal Society, and was awarded the Copley Medal of the society in 1921. Always deeply attached to his native country, Ireland, he entered Parliament in 1911 as Unionist representative of Cambridge University and served there for eleven years. He received various distinctions besides those mentioned.

Larmor grew to scientific maturity at a time when every attempt was being made to explain all physical phenomena on a dynamical or at least a quasi-dynamical basis, involving the concepts of absolute space (the ether), of absolute time and simultaneity, of

mass and force, characteristic of the Newtonian era of physical speculation. Larmor was already forty-three years of age when Planck in 1900 propounded his revolutionary idea of quanta of energy, destined to modify profoundly the current of physical ideas. In 1905 Einstein formulated his justly celebrated special theory of relativity, which was equally subversive of accepted classical ideas.

Up to that time Larmor and his great compeer, the Dutch mathematical physicist, H. A. Lorentz, were both well in the van of the group attempting to reconcile current dynamical and electrodynamical theories, and in particular to explain the null effects of the famous Michelson-Morley experiments of 1887 and other attempts to ascertain the absolute motion of the earth in space. It had occurred somewhat earlier (around 1892) to another noted Irish mathematical physicist, Fitzgerald, as well as to Lorentz, that there might occur a minute contraction of length in the direction of motion, often called the "Fitzgerald-Lorentz contraction," which would explain such null results. But it was Larmor who, working independently in the same circle of ideas, began to undertake a thoroughgoing mathematical study of the whole situation involved.

The outcome was his great book "Aether and Matter" of 1900, which was perhaps his crowning achievement. As he states in the Introduction, "a complete formal correlation is established between the molecular configurations of a material system at rest and the same system in uniform translatory motion, which holds good as far as the *square* of the ratio of the velocity of the system to the velocity of radiation. This correspondence carries with it as a consequence the null result, up to the second order, of the very refined experiments of Michelson and Morley. . . ." Beyond the second order of this velocity ratio, Larmor was not much interested, since such small effects would be well outside of the range of experimental determination. Indeed, the whole spirit of the work, in a mathematical sense, is extremely close to that of Einstein's later special theory of relativity of 1905, as the above quotation sufficiently shows, even if the concept of the ether as a particular frame of reference is employed.

Larmor goes so far in this book as to speculate concerning the explanation of gravitation from the same point of view. In a section with the title "Are the linear equations of the Aether exact?" (p. 186), he asks boldly: "Why then should not relatively minor phenomena like gravitation be involved in similar non-linear terms . . . in the analytical specification of the free aether . . .?" At the end he concludes somewhat in favor of the "natural prepossession" that the equations are truly linear, and so against his own extremely interesting suggestion.

The now familiar complete ("relativistic") form of the ponderomotive forces of the electromagnetic field and the corresponding Lorentz (or Larmor-Lorentz!) transformations are used in this notable work. This was essentially completed in 1898 (see the Preface). It was not until the end of 1903 that Lorentz's important article on electromagnetic theory in the German Mathematical Encyclopedia appeared. In his later article on "Relativity" in the Encyclopedia (1920), Pauli has stated the case thus (section 1, my translation):

> Now it became important to work this "Lorentz-contraction" organically into the theory, and also to clear up the other negative attempts to find an influence of the earth's motion upon phenomena. Here Larmor is to be mentioned first, who already in 1900 set up the formulas now generally known as the Lorentz transformation, and thus also had in view the variation of time-measurement. Lorentz's comprehensive article which was finished at the end of 1903, added some brief comments, which were to show themselves later very fruitful. . . .

Larmor himself has said a generous final word of appraisal on this question of priority. (Appendix II, (1927) "On Relativity and Convection," Vol. 1, Mathematical and Physical papers (1929)):

> This transformation was developed for the complete scheme of the electric equations of the field . . . in *Aether and Matter* (1900), Chap. XI, but only up to the second order of v/c; being so restricted on the tacit ground that the finite size of the electrons . . . must in any case introduce uncertainty beyond the order of 10^{-10} [cm.]. . . . This complete scheme for the electromagnetic field *outside the atomic sources* was obtained in exact form independently by Lorentz (1904) . . .; and the correspondence leading to it is appropriately called by his name as having been the initiator . . . in 1892.

Under the impact of the radical new theories, Larmor refused to abandon without further consideration the classical point of view which had served so well. He had realized very clearly how dynamics and electrodynamics were united deeply by means of the Principle of Least Action of Lagrange and Hamilton to which he always attached the greatest importance. However, there was a definite difference between his apologetic attitude for his lack of active mastery of quantum mechanics and its spectroscopic applications, and his repugnance, not so much towards relativity as for the setting in which it had been presented. Regarding the first, he says in the Preface to the second volume of his Papers: "the modern constructs in the problems of quantified spectroscopy . . . highly successful in their special fields . . . have hardly been entered upon [by himself], because the vast and tentative literature could not be justly appreciated except by a critic closely cognizant of the diverse evolutions of the last fifteen years in this field of knowl-

edge." But, regarding the second, he speaks of special relativity as follows in the Appendix quoted above: "All convection, uniform translatory motion [in free, *i.e.*, empty aether], would then be indeterminate, there being no standard frame in which to locate it . . .: it in no way discredits the theory of an aether, unless the intrinsic atoms of matter can be abolished also." Larmor characterizes Einstein's postulate of relativity as an "algebraic correspondence," "masquerading in the language of kinematics." The second gravitational theory of relativity of Einstein (1915) is epitomized as an "auxiliary construct," while "the absence of space and time and motion in the auxiliary construct is against reality."

It is distinctly interesting to observe that although Lorentz followed the brilliant new theories with all attention and determination, yet there remained in his mind vestiges of similar feelings. Thus he states in his Leyden Lectures 1910–12 (Silberstein-Trivelli's translation): "If we do not like the name of the 'aether' we must invent another name as a peg on which to hang all these things," and "can not deny to the bearer of all these properties a certain substantiality; and if so, then one may in all modesty call true time the time measured by clocks which are fixed in this medium and consider simultaneity a primary concept."

One may sympathize with, and admit the accuracy in detail of Larmor's position in regard to the relativistic theories: it is true that the work of Fitzgerald, Larmor, Lorentz and Poincaré had shown the special theory of relativity to be "just around the corner"; but it was only Einstein who grasped the significance of the actual situation. It is likewise true that the general theory of relativity of 1915 has not effectively entered into physical speculation; yet this second achievement of Einstein has also exerted a considerable influence on the course of physical thought. In fact it has been Planck and Einstein together who have broken the magical spell which the classical concepts of Newton had cast over scientific and philosophical thinking.

Larmor's mathematical-physical contributions extend over the entire classical field. His papers are extremely thoughtful and always repay careful reading. In the field of electromagnetism his contributions have been especially influential. Larmor's formula for the rate of radiation of energy from an accelerated electron is well known to all physicists, and the dispersion formulas due to him and Lorentz have been very useful.

When occasion required, he brought in subtle mathematical considerations, and always had the greatest appreciation of purely mathematical work. Indeed a number of his papers are essentially mathematical in character. His Presidential Address of 1916 before the London Mathematical Society, "The Fourier Harmonic Analysis and its Scope in Physical Science," shows a deep intuitive insight into the nature of these remarkable series, and a wide knowledge of their extremely varied applications.

Larmor was a well-known and much valued figure at International Mathematical Congresses, being a participant in the Rome Congress of 1908 and the three succeeding congresses at Cambridge, England (1912), at Strassbourg (1920) and at Toronto (1924).

The unmistakable impression which one gathers from his activities and writings, and from accounts by those who have known him, is that of a life of absolute sincerity and of unselfish devotion to the highest ideals, scientific and personal. He had a deep sympathy with younger people as witnesses, for example, his bequest to the University of Cambridge for medical and surgical assistance to the younger members of the faculty.

His own attitude is clearly revealed at the end of the first part of his Presidential Address, referred to above, where he tries to look forward in the midst of the First World War to "the promise of nobler and more disinterested times." Perhaps, in the midst of the second World War, we could not close in any way that would be more in accord with his outlook upon life than in voicing, as he did, the hope expressed by Shelley:

> The world's great age begins anew,
> The golden years return,
> The Earth doth like a snake renew
> Her winter weeds outworn.
>
> . . . . .
>
> A brighter Hellas rears its mountains
> From waves serener far,
> A new Peneus rolls his fountains
> Against the morning star.

WHAT MORE CAN ENGINEERING COLLEGES DO THROUGH ESMWT?[1]

By Dean GEORGE W. CASE

DIRECTOR OF ENGINEERING, SCIENCE AND MANAGEMENT WAR TRAINING DIVISION (ON LEAVE AS DEAN OF THE COLLEGE OF TECHNOLOGY, UNIVERSITY OF NEW HAMPSHIRE)

THIS topic is stated as a question. In line with the policies established since this program began, the effort will be to furnish information that may be useful to the institutions in answering the question

[1] Address at the fifty-sixth annual conference of the Association of Land-Grant Colleges, Chicago, October 28, 1942.

for themselves. This information will be in the nature of a progress report covering the period since Dean Seaton's report as director of ESMDT, made to this group one year ago.

By way of review, you may recall that the EDT program, starting in December, 1940, and with all courses closing before September 30, 1941, had a total of 120,000 enrolments. The ESMDT program, which was getting well under way one year ago, had a total for the year of about 438,000. In the current program, which is called Engineering, Science and Management War Training (ESMWT), the last available report shows 107,000 enrolments in classes active or completed. In addition, courses have been approved to start with additional authorized enrolments of 160,000.

The appropriation for the EDT program was $9,000,000, of which about 8¾ million had been allotted to approved courses at the close of the fiscal year. The ESMDT program had an original appropriation of 17½ million dollars, and a supplemental appropriation of 3 million, which unfortunately was not available until about May 1. This made a total of 20½ million available, of which about $20,300,000 was allotted to approved courses at the close of the fiscal year on June 30, 1942. The ESMWT program has an appropriation of 30 million dollars. This program started off very actively on July 1 with about 500 course proposals on hand to be approved as soon as the fiscal year had begun. Since July 1, proposals have been approved at about the rate of 1,000 per month, and with the preliminary estimated costs amounting to about 3 million dollars per month or at the rate of 36 million dollars for the fiscal year. It may be expected that the program will accelerate after the summer months are over, and on this basis an appropriation of 30 million dollars hardly looks sufficient. However, the office has learned by experience to expect a decrease of 20 to 30 per cent. between the cost estimates on preliminary proposals and the actual cost of the courses due partly to estimates being for a maximum enrolment. It appears from the figures available so far that the needs for training will make full use of the appropriation, or that they may somewhat exceed the appropriation. However, up to the present time, it has not been considered advisable to seek a supplemental appropriation.

In the plans for a program for 1943–44, a budget request has been submitted for an appropriation of 40 million dollars. This is based upon estimates of the Department of Labor that an employment peak for war workers will be reached about December, 1943.

There have been a number of developments in the nature of the program, one of the most significant of which is the increase in the number of women being trained. In the EDT program, the enrolments of women amounted to 811 out of a total of 120,000, or less than .7 of 1 per cent. In the ESMDT program, the enrolments of women amounted to 38,000 out of a total of 438,000 or nearly 9 per cent. In the ESMWT program, the enrolment of women has been running about 16 or 17 per cent. and is expected to increase.

A large number of the women are being enrolled in engineering drafting courses; others in ordnance inspection courses; still others in courses for the training of chemical technicians; and a number in the management field. The Civil Service Commission is requesting a full-time course of about ten weeks by which they hope to qualify women graduates in arts and sciences to take positions as junior engineers in federal services for which the commission recruits personnel.

Another trend in the program which appears to be increasing is full-time courses in which the students receive pay while they are in attendance in the course. This practice was established by the Army and Navy in such courses as Ordnance Inspection, Radio Inspectors or Technicians, etc. These courses, which include only civilian personnel, have run in length from about eight weeks to 26 weeks. In addition, the number of courses for commissioned officers has increased somewhat.

During this calendar year, full-time courses in which industry paid the students while attending have appeared in California and New Jersey. The number of such courses is small at the present time, but it does appear that industry in a number of states is interested in this method of securing trained employees. They are experimenting with it cautiously. If their needs become more urgent, this program may include more full-time courses on this basis.

The Civil Service Commission is also interested in the organization of courses on this full-time basis with pay. In these cases, the pay of the trainees would have to come from the departments of the government in which the trainees are to be employed. It is not certain at the present time how far this movement will go.

One development worth noting is the effort of the Civil Service Commission to make use of training which has already been given in ESMDT and ESMWT courses. The commission has taken from the files the names of several thousand trainees in fields in which they had urgent demands. They are sending application forms to these men at the rate of 2,500 per week and they report that they have secured applications from about 6 per cent. of this group. In order that the program may provide this service to the Civil Service Commission without interfering with the plans of industry, enrolment cards of men destined for industry should be stamped "Industry"

before being sent to Washington. The commission has also established the practice of surveying the lists of courses as they are approved, and attempting to get applications from the trainees in selected courses while the courses are in progress. About 3,000 trainees are being contacted per week in this manner at the present time, but it is too early to know how successful this effort will be.

One year ago the ESMDT program was engaged in the establishment of the course in Ultra-High Frequency Techniques at 40 engineering schools to meet an urgent need in the manufacture, operation and maintenance of aircraft detection equipment. The establishment of this course was preceded by an instructors' conference at the Massachusetts Institute of Technology, held in November, 1941. Before the fiscal year had closed, this course had been conducted in 45 institutions and had been given to about 1,100 senior students in electrical engineering or with majors in physics. At the close of the school year, the number that had been secured by the Army and Navy for the operation and maintenance of their aircraft detection equipment was small due to delay in contacting the men. Since that time, however, it appears that others have gone into the Army or Navy for this type of service.

During April and May, the institutions which had conducted these courses secured from their previous electrical engineering graduates about 1,100 applications for commissions in the Army or Navy, to enter upon this specialized field. From these applications, nearly 400 men were commissioned and sent to special full-time courses, including the Ultra-High Frequency Techniques. These men are now in service.

The schools are equipped and are willing to train additional groups of commissioned officers selected from the graduates of previous years, but the difficulty lies in finding such groups to be commissioned and trained. A recent canvass by the ESMWT office of 3,300 graduates secured less than 100 replies, indicating a lack of interest in commissions and training for this field. It appears that the primary service of the schools in Ultra-High Frequencies will be found in giving this course to their senior students.

During the summer, 20 additional institutions were authorized to conduct this course for their seniors, and a second instructors' conference was held at the Massachusetts Institute of Technology about September 1, at which representatives of 60 institutions were present. It is expected that in the 65 institutions participating in this work during the present school year approximately 1,300 senior students will receive the training, and it is evident that this year the Army and Navy intend to be much more prompt in contacting these men and securing more of them for the armed forces.

During the year the program had some experience in using radio broadcasting. The National Association of Broadcasters and associated stations, upon requests or encouragement from the Army and Navy, conducted a vigorous campaign of soliciting students in Fundamentals of Radio and the ESMDT office went along with this effort for a few weeks. It soon became evident, however, that this method of contacting and enrolling trainees had two serious faults. First, the number that could be enrolled by this method in a popular subject like radio was much more than the ESMDT funds could care for. Second, the method was not sufficiently selective. In the flood of applications most institutions were unable to select those who were likely to enter radio industry or radio service in the armed forces, and too large a percentage of the training appeared to be serving no immediately useful purpose in the war effort. Accordingly, this method of enrolment was discontinued.

There was and is, however, an urgent need for radio technicians, and when the supplemental appropriation became available, this training was resumed in a more orderly way with enrolments to be restricted to those employed in the radio industry, those enlisted in the Signal Corps reserve or those who were definitely headed for one of these services. Radio announcements have recently been used again quite successfully by having the announcement made or controlled by officers of the school or of the Signal Corps.

The complete story indicates that carefully controlled radio announcements, coupled with careful selection of applicants, may be quite useful, but that an uncontrolled broadcasting campaign is hardly compatible with efficiency in training for immediate service.

The ESMWT director and staff are constantly facing questions as to what may be included under this program. The Appropriation Act provides for courses to meet the shortage of engineers, chemists, physicists and production supervisors in fields essential to the national defense. It is always embarrassing when a well-planned course to meet some really urgent need must be disapproved on the ground that it has not been legally authorized in the act. But the Budget Bureau and Congressional committees have made it clear that even in this war emergency this limitation in the Appropriation Act should be observed with due care.

Doubtful borderline cases are often referred to the legal staff for a ruling. The question of training navigators for service at sea or in the air has been discussed by the Regional Advisers, the National Advisory Committee, and finally referred to the legal counsel of the Federal Security Agency. Excerpts from this opinion were sent to the institutions. The opinion does not support our giving courses in navi-

gation for deck officers or airplane pilots under the act appropriating funds for the ESMWT program.

On the other hand, a course in navigation requested for engineers in the Engineers' Corps of the Army has been considered acceptable. Likewise, courses in sanitation may be given for engineers but not for health officers. The act authorizes us to approve courses that are needed for the training of engineers, chemists, physicists and production supervisors, but this authorization does not include the same courses for persons engaged in other activities.

Courses to train teachers for teaching in this program have never been questioned, but the legality of courses in mathematics and physics for high-school teachers was not clear and no steps were taken in this direction until a legal ruling in their favor had been obtained. This favorable ruling was based upon the need for this training to meet teacher shortages which would affect adversely the qualifications of high-school graduates to take courses in engineering and physics. During the past summer, such courses were approved as an aid in providing high-school students with the foundation necessary for engineering training and thus being a step towards meeting the shortage of engineers. These courses will be continued on a part-time basis to upgrade high-school teachers where institutions find it feasible.

For high-school teachers in the more remote areas where the need is most acute, the correspondence method of instruction has been adopted after some study. This correspondence method will be limited to one standard course in physics and one in mathematics. The outlines and lesson materials for these are being prepared by a committee of experienced correspondence method teachers, headed by Dean F. O. Holt, of the University of Wisconsin. The courses will be made conveniently available to all sections of the country through about 20 institutions with long experience in conducting correspondence courses.

These borderline cases have been mentioned to indicate the type of questions that must be answered one way or the other. The institutions have accepted in a cooperative spirit the decisions that were reached, even though they may have had difficulty in agreeing with some of them.

There have been newspaper reports of overhead reorganizations in Washington affecting this program, and many here present may have questions whether this will affect the program. So far, no direct effect on the working of the program has been apparent.

This program operates in the Office of Education through powers and responsibilities delegated to the director by the commissioner of education. The Office of Education until recently has been entirely within the Federal Security Agency, of which Paul V. McNutt is the administrator. A recent order by the President transferred the functions relating to war training in the Office of Education from the Federal Security Agency to the War Manpower Commission, of which Mr. McNutt is chairman. The effect of this order is to change the organization under which the program operates. In the War Manpower Commission, President Edward C. Elliott, of Purdue University, as the chief of the Professional and Technical Personnel Division, has general direction of this program as well as that of the National Roster of Scientific Personnel, and the Procurement and Assignment Service for Physicians, Dentists and Veterinarians.

The War Manpower Commission operates many designated activities through 12 regional directors who have authority throughout their regions. These designated activities include the training programs below college level, but not the college-level training.

In general, then, it appears that so long as Dr. Elliott is satisfied with the conduct of the program, and so long as the War Manpower Commission system of regional directors is not imposed on this program, this change in overhead organization will not materially affect the conduct of the program.

In conclusion, it is hoped that this progress report has been of interest and that it will be of assistance to the colleges in answering the question proposed as the topic of this paper.

OBITUARY

HARRISON ESTELL HOWE

HARRISON ESTELL HOWE, editor of *Industrial and Engineering Chemistry,* died from a heart ailment, at his Washington home on December 10, 1942. He was sixty years old and had been editor of the publication for twenty-one years. His demise brought to a close a remarkable life devoted to the service of the chemical profession. Under his editorship *Industrial and Engineering Chemistry* rose to the foremost publication in its field and exerted great influence during the years of rapid expansion of industrial chemistry.

Dr. Howe was born in Georgetown, Ky., in 1881, a son of William James and Mary (Scott) Howe. He was educated at Earlham College, Richmond, Ind., where he received a B.S. degree in 1901. He did post-graduate work in chemistry at the University of Michigan and at the University of Rochester, receiving the M.S. degree from the latter institution in 1913.

What was to be a long and profitable association with chemical industry began for Dr. Howe in 1902 when he became chemist for the Sanilac Sugar Refin-

ing Company in Croswell, Michigan. In 1904 he joined the staff of Bausch and Lomb Optical Company, Rochester, N. Y., where he was in turn chemist, office manager, and editor. He married, in 1905, Miss May McCaren. He joined Arthur D. Little, Inc., and Arthur D. Little, Ltd., in Boston and Montreal. In 1916–17 he was chemical engineer and assistant to the president of the Canadian branch of the Little firm. During World War I, Dr. Howe was consultant to the Nitrate Division of Army Ordnance.

In 1919 he became chairman of the Division of Research Extension of the National Research Council during which term he raised a considerable portion of the money necessary to build and furnish the Marine Biological Laboratories at Woods Hole, Mass., one of the largest and most important laboratories in the country devoted to study of ocean life. This position he terminated in 1921 when he assumed the editorship of *Industrial and Engineering Chemistry,* his title and position at the time of his death.

During his busy life, Dr. Howe's services to the chemical profession were recognized in many ways. Honorary degrees were conferred upon him by the University of Rochester, Sc.D. (1927); Southern College, LL.D. (1934); Rose Polytechnic Institute, Eng.D. (1936); South Dakota State School of Mines, D.Chem. (1939). Decorated in 1926 by Italy as an Officer of the Crown, Dr. Howe also received another outstanding honor on November 6, 1942, when the American Section of the Society of Chemical Industry awarded him the Chemical Industry Medal. This honor is granted yearly to outstanding scientists responsible for the application of research to industrial processes. He was also a fellow of the American Association for the Advancement of Science.

In 1922, Dr. Howe was chairman of the committee on work periods of the American Engineering Council of the Federated Engineering Societies, and he took a leading part in reducing the hours of labor in industry. A survey made by his committee showed that the tendency throughout the world was toward the eight-hour day and abolition of the prevalent twelve-hour day.

He was a trustee of Science Service and a member of the Purdue Research Foundation. Strongly in favor of scientists sharing in the wealth created through their discoveries, Dr. Howe was an advocate of action for devising a plan under which the legitimate claims of scientists to remuneration could be recognized. He was a member of the advisory board of the Lalor Foundation and general conference leader in the Institute of Politics, Williamstown, Mass., in 1926–29.

Dr. Howe was a colonel in the Chemical Warfare Reserve of the U. S. Army and a member of the A.C.S. advisory committee to that service. He was chairman of the Chemicals Group of the Chemical Priorities Committee of the Office of Production Management. Later he became chairman of the advisory committee of the Chemical Section of the War Production Board.

A member of many organizations, Dr. Howe brought to all of them his enormous capacity for work. He served two terms as director of the American Institute of Chemical Engineers and was their representative for ten years on the American Engineering Council of which he was treasurer for eight years. His work for the American Chemical Society, in addition to his editorship, entailed many committees and responsibilities too numerous to list. Suffice to say that he always had time to advise and labor in his chosen field and to him chemistry paid tribute by continually asking for his helping hand. His clubs included, among others, the Cosmos Club, the Torch Club and the Chemists' Club.

He had a deep and abiding interest in Rotary International. Their unselfish aims and desires for service to mankind appealed to him and gave him still another opportunity to serve. He was president of the Washington, D. C., club, governor of the 34th district, member of its magazine committee, and a director in 1936–37.

Throughout his life, Dr. Howe had been constantly in touch with the application of science, particularly in chemistry, to the problems of everyday life. He wrote and edited many volumes for the public, and among his works are "The New Stone Age"; "Profitable Science in Industry"; "Chemistry in the World's Work"; "Chemistry in the Home" and a series of six Nature and Science Readers for School Children (with E. M. Patch). He edited two volumes of chemistry in industry, 1924–25, prepared especially for use in connection with the American Chemical Society Prize Essay Contest. He was also author of numerous articles in scientific and lay publications.

Each activity and interest of Dr. Howe's was investigated and worked with remarkable thoroughness. He became one of the best public speakers on chemistry in the United States. No one hearing him speak about the many wonders he brought up from his "magic grab bag" will soon forget the intensely interesting and lucid comments which accompanied each showing. His principal hobbies were gardening and photography and to each he gave his full energies. Thus at his homes in Washington and Woods Hole, he grew many prize winning flowers and planned gardens extensive and excellent. He had an enormous collection of colored transparencies and motion pictures which were remarkable for their variety. He practiced scientific farming at his farm in Richmond, Indiana.

Dr. Howe is survived by his wife, Mrs. May McCaren Howe, two daughters, Mrs. Oscar A. Provost, Mrs. Frank B. Clinton, five grandchildren, and a sister, Mrs. Jeanette Wilson.

American chemistry has lost an outstanding figure in the death of Harrison Estell Howe. His abilities and willingness to apply them for the good of mankind are attributes too seldom found. His passing is sorely mourned.

F. J. VAN ANTWERPEN

RECENT DEATHS

DR. CLINTON H. CURRIER, who retired in 1938 as associate professor of mathematics and astronomy at Brown University, died on January 5, at the age of sixty-seven years.

DR. MAX MELTSNER, associate professor of chemistry at the College of the City of New York, died on January 16. He was in his fifty-seventh year.

DR. SUSAN P. NICHOLS, professor emeritus of botany of Oberlin College since 1939, after having been a member of the faculty for 31 years, from 1933 to 1938 head of the department, died on December 7, at the age of sixty-nine years.

ARTHUR H. NORTON, curator of the Portland, Maine, Society of Natural History, died on January 5, at the age of seventy-two years.

CHARLES H. WARD, president of the Anatomical Laboratory of Charles H. Ward at Rochester, N. Y., died on January 18, at the age of eighty years.

SIR WILLIAM ARBUTHNOT LANE, the British surgeon, died on January 16, at the age of eighty-six years.

SCIENTIFIC EVENTS

JOINT COUNCIL OF SCIENTIFIC MEN IN GREAT BRITAIN

Nature states that a Joint Council of Professional Scientists, representing more than ten thousand qualified men of science, has been set up in Great Britain under the chairmanship of Sir Robert Pickard by the Institutes of Chemistry and Physics in association with representatives of professional botanists, geologists, mathematicians and zoologists. The council has been established to voice the collective opinion of scientific men on matters of public interest, to provide a liaison between professional organizations of scientific men for coordinated action in matters of common interest, and in particular to concern itself with (1) the utilization of men of science to the best advantage in the service of the community; (2) the education, training, supply and employment of scientific workers; (3) the better understanding of the place of men of science in the community; (4) the maintenance of adequate qualifications and ethical standards among professional men of science; (5) the supply of information and advice to public and other bodies on matters affecting men of science.

The members of the council are as follows: *Institute of Chemistry:* Dr. J. J. Fox, Professor Alexander Findlay, Dr. G. Roche Lynch, Sir Robert Pickard, Dr. H. A. Tempany, R. B. Pilcher; *Institute of Physics:* Sir Lawrence Bragg, Professor J. A. Crowther, E. R. Davies, Dr. B. A. Keen, Dr. H. Lowery, Dr. H. R. Lang; *Representing Botanists:* Professor W. Brown; *Representing Zoologists:* Professor D. Keilin; *Representing Mathematicians:* Professor S. Chapman; *Representing Geologists:* Professor H. H. Read. The joint council has been established for the period of the national emergency, but it may form the nucleus of some more permanent organization to facilitate the close collaboration between professional men and women practising in all branches of science. Communications to the council should be addressed to Dr. H. R. Lang, Honorary Secretary, Joint Council of Professional Scientists, care of Institute of Physics, at its temporary address, The University, Reading, Berks.

COMMITTEE ON SANITARY ENGINEERING OF THE NATIONAL RESEARCH COUNCIL[1]

A SANITARY engineering committee has been organized, at the request of the Surgeon General of the Army, by the National Research Council through the Division of Medical Sciences acting for the Committee on Medical Research of the Office of Scientific Research and Development. Through liaison officers, advice and assistance on sanitary engineering problems are also furnished to the Navy and the Public Health Service.

As epidemiologic and entomologic advice was deemed necessary, personnel representing these sciences was included. Close liaison with the Surgeon General's Office is maintained through the Sanitary Engineering Branch of the Division of Preventive Medicine. The committee consists of:

Abel Wolman, *chairman*, professor of sanitary engineering at the Johns Hopkins University.

Kenneth F. Maxcy, *secretary*, professor of epidemiology

[1] The *Journal* of the American Medical Association.

at the School of Hygiene and Public Health, the Johns Hopkins University.

Harold E. Babbitt, professor of sanitary engineering at the University of Illinois.

F. C. Bishopp, assistant chief of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

V. M. Ehlers, chief engineer of the Texas State Board of Health, Austin.

Gordon M. Fair, professor of sanitary engineering at Harvard University.

H. A. Whittaker, chief engineer of the division of sanitation, State Department of Health, Minneapolis.

In the several meetings to date, the committee has devoted major efforts to the problem of procurement and training of the large number of sanitary engineering personnel required for essential war activities. In addition to the needs for sanitary engineers as commissioned officers in the Sanitary Corps of the Army, the U. S. Public Health Service and the Corps of Engineers utilize sanitary engineers on a civil service status.

The committee has also considered the sanitary engineering functions performed by the Sanitary Corps of the Army with a view toward providing constructive suggestions on the many problems occasioned by the war, including the safeguarding of army water supplies, the disposal of waste and malaria control.

The program covering future activities of the committee includes a continuation of its present work on the availability of and the demand for sanitary engineering personnel, the orderly procurement of and assignment to military, semi-military and civilian agencies of trained sanitary engineers, information on military sanitary engineering problems and their solution and a consideration of postwar needs for sanitary engineers and the fields in which they may be most profitably utilized.

The committee has had strong liaison representation from the War Department by the presence in the deliberations of Colonels Simmons, Hardenbergh, Prentiss and Robinson; from the Navy by Admiral Stephenson and Commanders Cushing, Tipton and Burton; from the U. S. Public Health Service by J. K. Hoskins, and from the Selective Service in the person of Major Robert A. Bier. The National Research Council representatives in the deliberations have been Drs. Weed, Davison and Forbes and Colonel Larkey.

PRESENTATION OF THE MELCHETT MEDAL

As already noted in SCIENCE the Melchett Medal, awarded annually by the Institute of Fuel, England, for outstanding achievement in work involving the scientific preparation or use of fuel, was presented this year to Arno C. Fieldner, chief of the Fuels and Explosives Service, U. S. Bureau of Mines. Dr. Fieldner was the second American to be so honored.

Chemical and Engineering News gives the following account of the presentation:

Because Dr. Fieldner was unable to go to England to receive the medal, he gave his lecture, "The Analysis and Testing of Coal in Relation to Its Properties and Utilization," in the Bureau of Mines sound-film studio in Pittsburgh, Pa., where it was recorded on a 16-mm film. The film was sent to England and by this means Dr. Fieldner was able to deliver *in absentia* the Melchett Memorial Lecture at the opening meeting of the institute on October 13, 1942. The medal was received formally at this time by a member of the American Embassy, who in turn transmitted it to the American Society of Mechanical Engineers, and it was formally presented to Dr. Fieldner at the annual banquet of that society in New York on December 3, 1942. The presentation was made by Arthur Selvey, son of the president of the Institute of Fuel, who is an engineer with the Detroit Edison Company.

This unique procedure was received with enthusiasm by the members of the Institute of Fuels, who were given an introduction to the author by photographic proxy while listening to an address of considerable interest, and who appreciated the care with which the film had been prepared.

AWARDS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

AT the ninetieth meeting of the American Society of Civil Engineers, which was held in New York City on January 20 and 21, the following honors were conferred:

The Norman Medal to Karl Terzaghi, lecturer, Harvard University, for paper entitled "General Wedge Theory of Earth Pressure."

The J. James R. Croes Medal to Charles F. Ruff, sanitary engineer, Caribbean Architect-Engineer, New York, N. Y., for paper entitled "Maximum Probable Floods on Pennsylvania Streams."

The Thomas Fitch Rowland prize to Shortridge Hardesty, consulting engineer, Waddell and Hardesty, New York, N. Y., and Alfred Hedefine, associate engineer, Waddell and Hardesty, New York, N. Y., for paper entitled "Superstructure of Theme Building of New York World's Fair."

The James Laurie Prize to W. Watters Pagon, consulting engineer, Baltimore, for paper entitled "Transatlantic Seaplane Base, Baltimore, Maryland."

The Arthur M. Wellington Prize to William J. Wilgus, Ascutney, Vt., for paper entitled "The Grand Central Terminal in Perspective."

The Collingwood Prize for Juniors to John F. Curtin, senior civil engineer, the Texas Company, New York, N. Y., for paper entitled "Bridge and Tunnel Approaches."

The Rudolph Hering Medal to Robert T. Regester, consulting engineer, Baltimore, for paper entitled "Problems and Trends in Activated Sludge Practice."

The Construction Engineering Prize to Rear-Admiral Frederic R. Harris, U.S. Navy (retired), consulting en-

gineer, New York, N. Y., for paper appearing in June, 1942, issue of *Civil Engineering* entitled "Evolution of Tremie-Placed Concrete Dry Docks."

The Daniel W. Mead Prize to Alfred C. Ingersoll, research engineer, The Linde Air Products Company, Tonawanda, N. Y., for the best paper submitted by a student on "Ethical Standards and How Best They Can Be Developed."

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE national technical meeting of the American Institute of Electrical Engineers will be held in the Engineering Societies Building from January 25 to 29.

According to a statement made by Floyd A. Lewis, acting editor of *Electrical Engineering,* emphasis at this year's meeting will be on war problems. Several of the technical sessions and conferences will concern conservation of critical materials through more efficient utilization of such materials as are used on electrical systems. In addition to the twenty-one technical sessions, sub-sessions and conferences, there will be a general session on Wednesday morning, January 27, devoted to engineering man power in the war effort. Also at this session, which will be presided over by the president of the institute, H. S. Osborne of New York, the Alfred Noble Prize will be presented to George W. Dunlap.

Another feature of the meeting will be the presentation of three engineering awards at a special session held on Thursday evening. The Edison Medal, highest award of the institute, will be presented to Major Edwin H. Armstrong, professor of electrical engineering, Columbia University, who has contributed so much to radio. The John Fritz Medal, awarded jointly by a group of national engineering societies including the institute, will be presented to Dr. Willis R. Whitney, vice-president in charge of research of the General Electric Company, Schenectady, N. Y. The Hoover Medal, also a joint award, will be presented to Dr. Gerard Swope, president of the General Electric Company, New York, N. Y. Following the medal-presentation ceremonies, Dr. George C. Southworth, of the Bell Telephone Laboratories, will deliver an address entitled "Ultrahigh Frequencies." This should be of especial interest in view of the wide application of ultrahigh frequencies or so-called "microwaves," in the present war.

The American Institute of Electrical Engineers has the largest membership of any of the leading national engineering societies, numbering 19,916; there are 72 local sections in major North American cities, and 124 student branches in engineering schools. The winter national technical meeting is one of three national and several regional meetings held each year for the purpose of reviewing and discussing important technical and related developments. Emphasis at all these meetings for the current year is on war problems. Registered attendance at recent winter meetings has exceeded 1,600, and there is every reason to believe that the attendance this year will be up to its usual standard.

CANCELLATION OF THE ANNUAL MEETING OF THE AMERICAN PHYSIOLOGICAL SOCIETY

THE American Physiological Society has issued the following statement:

For the first time in the history of our society it has seemed wise to cancel the annual meeting. Action in this direction was first taken by the executive committee of the federation, which voted 11 to 2 in favor of cancellation of the meeting of the federation to be held in Cleveland from April 6 to 10. On referring this matter to the individual councils of the several societies, the action was ratified by a majority of each of the separate councils. Our own council further voted (5 to 2) not to hold an annual meeting independently of the federation.

The chief reasons given for this decision were (1) the difficulty of transportation and the request by Mr. Eastman, Coordinator of Defense Transportation, "that conventions should not be held unless they are related to the war effort." (2) The advice of the Science Advisory Committee of the National Resources Planning Board "that meetings not closely connected with the war effort should be postponed" and the suggestion "that some large associations may find it advantageous to organize their annual meeting in regional gatherings rather than in a single meeting in one place." (3) The difficulty of making our meeting a material contribution to the war effort because of (a) confidential nature of much if not most of the research work being carried on by our members, (b) preoccupation of potential speakers with other more essential war work, and (c) added teaching burdens in all our laboratories.

SCIENTIFIC NOTES AND NEWS

DR. PERRIN H. LONG, professor of preventive medicine at the Johns Hopkins Medical School, has received the award of the Southern Medical Association for original work by one of its members. The award was made in recognition of his studies on the sulfonamides.

THE Octave Chanute Award of the Institute of Aeronautical Sciences has been made to A. Lewis MacClain, aircraft engine test pilot and engineer of the Pratt and Whitney Aircraft Division, of the United Aircraft Corporation, East Hartford, Conn., in recognition of the development of the engine torque

indicator, which measures brake horsepower, a practical device for accurately measuring the power output of a plane engine during flight. Presentation of the award will be made at the honors night dinner of the institute on January 26.

DR. JOHN R. MOHLER, chief of the United States Bureau of Animal Industry, was the recipient of an alumni award of merit at the Founders Day ceremonies on January 16 of the University of Pennsylvania.

DR. DONALD D. VAN SLYKE, member of the Rockefeller Institute for Medical Research, New York, has been elected an honorary member of the British Physiological Society.

DR. R. G. HOSKINS, of the Harvard Medical School, has been elected an honorary member of the Asociación Médica Argentina.

DR. JOHN R. LEWIS, professor of chemistry in the University of Utah, has become professor and head of the department of metallurgy. Dr. Lloyd E. Malm, associate professor of chemistry in the Utah State Agricultural College, at Logan, has been appointed associate professor of chemistry at the university.

THE *Journal* of the American Medical Association reports that Dr. Evelyn B. Tilden, of the Rockefeller Institute for Medical Research, has been appointed associate professor of bacteriology at the Medical School of Northwestern University.

OFFICERS of the Genetics Society of America elected for the year 1943 are: Professor Marcus M. Rhoades, Columbia University, *President;* and Professor G. W. Beadle, Stanford University, *Vice-president.* The executive committee for 1943 is composed of these two officers together with Professor Th. Dobzhansky, Columbia University, and Professor E. W. Lindstrom, Iowa State College, presidents for 1941 and 1942, and Dr. B. P. Kaufmann, Carnegie Institution, Cold Spring Harbor, N. Y., *Secretary-treasurer.*

AT the meeting of the Rittenhouse Astronomical Society on January 8, Armand N. Spitz was installed as president. Dr. Charles P. Olivier, director of the Flower and Cook Observatories of the University of Pennsylvania, delivered the address of the retiring president. His subject was "Observational Practice for Variable Stars."

AT the seventy-fourth annual meeting on January 11 of the Board of Trustees of the American Museum of Natural History, Colonel F. Trubee Davison was reelected president of the museum. Other reelections were A. Perry Osborn, *First vice-president;* Cleveland E. Dodge, *Second vice-president;* E. Roland Harriman, *Treasurer,* and Clarence L. Hay, *Secretary.* Colonel Davison is on active military service, and Mr. Osborn will continue as acting president. It was announced at the meeting that after the war the museum building at Central Park West and 79th Street will be modernized completely, both externally and internally.

THE Board of Trustees of the Carnegie Institution of Washington at their recent annual meeting elected Henning W. Prentis, Jr., president of the Armstrong Cork Company, Lancaster, Pa., a member of the board to fill the vacancy created by the death of Dr. Stewart Paton.

DR. EDWARD DAVENS, Baltimore, pediatric consultant to the Maryland State Department of Health, has been appointed chief of the Bureau of Child Hygiene to succeed Dr. James H. M. Knox. The appointment will take effect on September 1.

DR. J. S. SWEARINGEN, professor of chemical engineering at the University of Texas, has leave of absence to join the Office of Scientific Research and Development.

PROFESSOR EMERITUS W. W. CHARTERS, of the Ohio State University, formerly director of the Bureau of Educational Research, has become chief of the training division of the War Manpower Commission.

AUSTIN W. CURTIS, JR., for eight years assistant to the late Dr. George Washington Carver, of the Tuskegee Institute, has been appointed his successor.

SIR JOHN C. G. LEDINGHAM, F.R.S., will retire on March 31 from the post of director of the Lister Institute of Preventive Medicine, London, which he has held since 1930. His successor will be Dr. A. N. Drury, F.R.S., Huddersfield lecturer in special pathology at the University of Cambridge, a member of the scientific staff of the Medical Research Council.

THOMAS E. MILLIMAN has resigned as chief of the agricultural-chemicals unit of the War Production Board and is returning to the Grange League Federation Exchange. His headquarters will be at Ithaca, N. Y., where he will be in charge of fertilizers and agricultural chemicals. Dale C. Keiffer, of Bethesda, Md., has been named acting chief of the unit.

DR. JOHN S. KARLING, professor of botany at Columbia University, a former director of the chicle research work of the Tropical Plant Research Foundation, has been granted leave of absence for the duration of the war to become botanical specialist in latex-bearing plants for the Department of Rubber Exploration of the American Republics Aviation. He will be associated with Dr. G. H. H. Tate, formerly of the American Museum of Natural History, in exploring the little known tributaries of the Tapajoz and Madeira Rivers in Brazil for untapped sources of wild rubber.

CLINTON G. ABBOTT, director of the Natural History Museum, San Diego, Calif., has been made a member of a Guayule Committee for the region of San Diego, to investigate possibilities of guayule cultivation, seed-collecting, planting, harvesting and suitable acreages.

DR. G. H. PARKER, Harvard University, lectured before the Royal Canadian Institute, Toronto, on January 9, on "The Coloration of Animals and their Ability to Change their Tints." He also spoke before the department of zoology of the University of Toronto "On the Cultivation of the Research Spirit."

DR. HOMER W. SMITH, professor of physiology and director of the Physiological Laboratories of the New York University College of Medicine, gave the William Henry Welch Lectures of the Mount Sinai Hospital of New York on January 5 and 12. He spoke on "The Physiology of the Kidney."

SIR STAFFORD CRIPPS, Julian Huxley and R. A. Watson-Watt will participate this week in a transatlantic short-wave discussion with Americans on the "Answering You" program of the British Broadcasting Corporation. The Americans, consisting of Watson Davis, Gerald Wendt and Samuel Kaiser, will question the British on the contributions of science to the war effort. The program may be heard over WNYC in New York on Sunday, January 24, at 5:30 P.M., and elsewhere over the Mutual network.

THE forty-fifth annual meeting of the Washington Academy of Science was held on January 21. Following the annual meeting, there was held the three hundred and sixteenth meeting of the academy with the following program: "Reports on Governmental Publication of Scientific Research" by Atherton Seidell, for the U. S. Public Health Service; by Melvin C. Merrill, for the U. S. Department of Agriculture, and by Kasson S. Gibson, for the National Bureau of Standards. "The Censorship of Scientific Publications Going Abroad" was described by Edward D. Hill, of the U. S. Board of Economic Warfare.

THE meetings of the Association for the Study of Internal Secretions, tentatively scheduled to be held in Cleveland, Ohio, on April 5 and 6, have been indefinitely postponed.

IN order to stimulate the investigation of cyclic phenomena the Foundation for the Study of Cycles, 400 West 118th St., New York, N. Y., will award a medal for the best work published on that subject in any field of science during 1943. The judges who will award the medal are: Dr. C. G. Abbot, secretary of the Smithsonian Institution, Washington, D. C.; Dr. Harold E. Anthony, dean of the scientific staff, American Museum of Natural History, New York; Professor W. C. Mitchell, Columbia University, director of the National Bureau of Economic Research; Professor V. C. Wynne-Edwards, biologist, McGill University, and Professor Ellsworth Huntington, geographer, Yale University, *chairman*.

APPLICATIONS to the Committee for Research in Problems of Sex of the National Research Council, for financial aid during the fiscal year beginning on July 1, in support of work on fundamental problems of sex and reproduction, should be received before April 1. They may be addressed to the Chairman, Dr. Robert M. Yerkes, Yale School of Medicine, New Haven, Conn. Although hormonal investigations continue to command the interest and support of the committee, preference, in accordance with current policy, will ordinarily be given to proposals for the investigation of neurological, psychobiological and behavioral problems of sex and reproduction.

COLUMBIA UNIVERSITY has announced gifts amounting to over $200,000. Among these the Josiah Macy Jr. Foundation contributed $150,000, to support a program of research and teaching in tropical medicine at the Medical Center over a five-year period. The Lillia Babbitt Hyde Foundation gave $20,000 to the radiological research laboratory, and Schering and Glatz, Inc., $10,000 for research projects in the department of bacteriology.

ANNOUNCEMENT is made of the establishment by the Gulf Oil Corporation of a fellowship in geology at the University of Chicago. The first award of this fellowship will be made for the school year 1943–44, provided qualified candidates are available under war conditions. The stipend will approximate $1,200 a year, the Gulf Corporation contributing $900 and the university making available additional funds or allowances equivalent to the tuition requirements, namely, $300. The initial award will be in the field of sedimentation, and candidates must have had the equivalent of at least a year of graduate work in geology at an institution of recognized standing. The fellowship holder will be expected to devote part of his time to research in sedimentation. The fellowship may be renewed on recommendation of the department. Renewal at the end of nine months, rather than at the end of a twelve-month period is possible if the fellow works under an accelerated program. Application forms may be obtained from the Department of Geology, University of Chicago, and must be returned to the university before March 1. The award will be announced on April 1.

A FOUR-TERM program in forestry, which could be completed in a year and three months under the accelerated program now in effect, is being planned by the School of Forestry and Conservation of the University of Michigan, of which Samuel T. Dana is

dean. Both the War Manpower Commission and Selective Service headquarters have recognized forestry, lumbering and logging as essential activities, and the new program is designed to train men for effective work in those branches of industry in which forestry and forest products are involved. Another objective is to train men so that they may qualify as officer material as quickly as possible after entering the armed forces, especially in forest regiments, engineering units, field artillery and infantry.

DISCUSSION

AGAR-BEARING SEAWEEDS AT LA JOLLA, CALIFORNIA[1]

THE use of red seaweeds as a source of jellies began and developed in the Far East. Nine tenths of the world's agar is produced in Japan by a purely cottage industry, while on the shores of China, Malaya, the East Indies and Ceylon, there is manufactured by native methods a jelly which, if dried, would be the agar of commerce. Of about thirty species of red algae which are recorded as agariferous, only four are used outside of the regions named. It is possible that on the southern and eastern shores of Asia all profitable sources of agar have already been found, but on the other coasts of the world there probably exist considerable resources of this kind which have never been developed. The prospect of competition with cheap Japanese agar has prevented large-scale investment in exploratory and developmental processes. In Russia, with government protection, there is a modern agar industry of less than ten years' standing, utilizing two species of seaweeds, *Ahnfeltia plicata* on the Maritime coast and in the White Sea and *Phyllophora rubens* in the Black Sea. In this country, repeated efforts during the last twenty years have finally established a modern manufacture utilizing *Gelidium cartilagineum* and *Gracilaria confervoides* collected on the coasts of southern California and Lower California.

With Oriental supplies of agar cut off, attention in this country has been turned to agar substitutes and the reclamation of agar, as recent notes in this journal testify. Believing with Humm[2] that, in addition, considerable domestic resources exist, both as unlocated beds of *Gelidium* and *Gracilaria* and as beds of red algae whose agar-producing potentialities have never been recognized, the authors have examined and tested several red algae growing at La Jolla in harvestable quantities. Restrictions on the use of boats at sea have delayed the extensive survey which the situation demands and limited us to collecting at low tide and by swimming and diving in shallow water. About two miles of exposed rocky shoreline have been covered and considerable quantities of agariferous seaweeds located.

The seaweeds were drained and weighed, freed of sand, shells and conspicuous contaminating species while being washed in tap water, dried in the sun and weighed again. Bleaching was not attempted. Fifty gram lots of dried material were weighed out and soaked in tap water for twenty-four hours except where otherwise noted. Each lot was drained and put into one liter of tap water. Sulfuric acid or sodium hydroxide was added to adjust the solution to pH 6.0, 8.0, 10.0 or 12.0, except as otherwise noted and the material cooked for twenty-four hours in a water bath. Distilled water was added periodically to replace evaporation losses. Every two hours a 25 ml sample was removed and cooled to 23°–25°. The strength of the jelly (if a jelly was formed) was measured with a Lipowitz meter as described by Kizevetter[3] in which a segment of a sphere of stated dimensions is driven through the surface of the jelly by weights. The pH was measured and, when necessary, acid or alkali was added to the parent lot to maintain the pH at the value fixed on initially. The cooled sample was stirred back into the parent lot. At the end of the single extraction a 100 gram sample was filtered through two layers of cheesecloth, cooled, frozen, chopped, thawed at room temperature, drained and air dried on a glass plate. The dried agar was weighed, and a 1 per cent. jelly was made from part of it for a strength test.

Six species were readily collected in sufficient quantities to test. *Gelidium cartilagineum* grows below the low tide mark and is collected commercially by divers working as deep as ten fathoms. However, fronds 50–75 cm long can be collected in quantity just below lower low tide. *Pterocladia sp.* grows low in the intertidal zone, the 12–18 cm fronds thickly covering exposed rocks. *Endocladia muricata,* 5–8 cm long, grows higher in the same zone. *Gigartina canaliculata,* with fronds 10–12 cm in length, also occurs in the intertidal zone. *Gigartina serrata* with fronds 20–30 cm. long grows below low tide, very densely in partially shaded places. *Gigartina asperifolia* was the only species collected which so far seems unsuitable as an agar source.

A year-round study will be necessary to establish the amounts of these seaweeds which, on the average, can be collected in a day, week or month and the annual harvest which can be expected from a section of coastline. In summer, with a calm sea, approximately 100 to 300 pounds of wet seaweed of any of the species named can be collected at one tide by our

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 187.

[2] H. J. Humm, SCIENCE, 96: 230–231, 1942.

[3] I. V. Kizevetter, *Bull. Pac. Sci. Inst. Fisheries and Oceanography* (*Russian*), 13: 1–135, 1937.

methods. The dry weight varies from 17 to 25 per cent. of the wet weight. The species growing near or below low tide are large and can be collected rapidly but only for a short time each day, while the species of the intertidal zone take more time to collect, but more time is available.

The yield of agar from *G. cartilagineum* was twice as great at pH 6.0 and pH 8.0 as at pH 10.0 and pH 12.0. In the case of one lot no acid or alkali was added and it maintained itself at pH 8.6 during the cooking. At pH 6.0 and pH 8.0 the strength of the jelly increased steadily during the first eighteen hours and afterwards remained unchanged until cooking was stopped after twenty-seven hours. This experience corresponds with the traditional Japanese method which includes the addition of a little vinegar to the cooking water and with the American commercial method in which no attempt is made to control the acidity.

The yield from *Pterocladia* was greatest at pH 6.0, but there was little difference between all lots except the lot at pH 10.0 which showed a very small yield. At pH 6.0 the maximum jelly strength was reached after fourteen hours cooking, after which a 20 per cent. decrease occurred. The greatest yield would probably have been obtained by stopping the extraction at pH 6.0 at the end of fourteen hours.

The yield of agar from *Endocladia muricata* was nearly twice as great at pH 12.0 as in any other lot. The maximum jelly strength was reached after fourteen hours' cooking and remained constant until cooking stopped. The yield of dry matter from *E. muricata* was about twice as great as from *G. cartilagineum* and from *Pterocladia*. However, the firmness of a 1 per cent. jelly was only half as great. Either *Endocladia* agar has a low jellying power or the crude dry extract contains considerable impurities.

None of the three species of *Gigartina* tested yielded a jelly after fourteen hours cooking at pH 6.0, 8.0, 10.0 or 12.0. In a second experiment, the alkalinity of the different lots was maintained by cooking in tenth molar calcium chloride, with excess calcium carbonate, or with excess calcium hydroxide, respectively. Under these conditions *Gig. canaliculata* at pH 12.0 (excess calcium hydroxide) yielded a soft jelly. Following the method described by Kizevetter[3] for the treatment of *Ahnfeltia plicata,* dried seaweed of each of the three species was soaked for three days either (a) in cold saturated calcium hydroxide or (b) in cold 2 per cent. calcium chloride. *Gig. asperifolia* was so badly disintegrated by these treatments that it could not be handled. The other two species yielded firm jellies after two to five hours' cooking either in 2 per cent. calcium chloride or in saturated calcium hydroxide. Under these conditions, the two species of *Gigartina* act like *Gracilaria* in yielding their agar readily.

The most important information obtained is that out of five species of red algae not previously considered agariferous, harvestable in moderate quantity at La Jolla without special equipment, four readily yielded agar, in quantity and quality equal to that obtained from red algae at present commercially exploited.

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EARLY MASTERY OF THE GROUP CONCEPT

ONE of the most interesting facts in the history of group theory is that those who are now commonly regarded as having been the most influential in extending the use of this theory are not also those who first mastered the concept of a group. Among the former Sophus Lie (1842–1899), Felix Klein (1849–1925) and Henri Poincaré (1854–1912) are widely regarded as the most eminent, while the latter are represented by Arthur Cayley (1821–1895), Leopold Kronecker (1823–1892) and Heinrich Weber (1842–1923). None of the former three seems to have ever assumed explicitly all the postulates of the concept of a group which are now commonly regarded as essential. The most fundamental omission is that the associative law must be satisfied when three or more elements of a group are combined. Such a combination has been most commonly called a multiplication, but in the recent literature it is often called an addition.

The interest in the noted omission is partly due to the fact that it exhibits the wide use in mathematics of unannounced restrictions even by some of the most eminent modern writers. It seems, therefore, questionable whether the freshmen in our colleges should be advised to pay close attention to the associative law, which was first thus named by the noted Irish mathematician, W. R. Hamilton (1805–1865), and was effectively introduced by him into the common mathematical literature. It is of great importance in abstract group theory, but the very successful use of group theory by the first three authors noted above implies that in many fields the group concept can be used successfully without restricting it by this law. At any rate, the history of group theory would not be complete without noting the comparatively late emphasis on this law in the development of this subject.

The six names mentioned in the first paragraph of this article exhibit the gradual development of the modern group concept which was practically completed by the last of these writers in the *Mathema-*

tische Annalen, volume 43 (1893). The given list of six does not include any American author, but all the writers included therein were very influential in starting work along this line in our country and some Americans, including E. V. Huntington, made further studies relating to the simplification of the postulates of the group concept. While Heinrich Weber may now be reasonably regarded as the first man who fully mastered the group concept (1893), it is of some interest to note that about three years thereafter he made an erroneous assertion relating thereto in the first edition of the second volume of his "Algebra" (1896) when he stated (page 54) that the most important example of a commutative group is the system of our natural numbers when they are combined by multiplication.

On account of the wide use of this algebra this error was often repeated by later writers and seems not to have been publicly corrected before the appearance of the second edition of this volume about three years later. It may remind one of the error committed by Sophus Lie on page 163 of volume 1 of his "Transformationsgruppen" (1888) where he asserted in effect that the numbers which are less than unity form a group when they are combined by multiplication. This error was repeated by Felix Klein several years later in the *Mathematische Annalen,* volume 43, page 66 (1893). It is, however, less striking than the one by Heinrich Weber to which we referred, since neither Sophus Lie nor Felix Klein ever definitely adopted the now common postulates of an abstract group.

Contrary to what might naturally be assumed, all the possible abstract groups of certain low orders were determined long before a satisfactory system of postulates of the group concept was published. Forward steps in the development of mathematical subjects frequently preceded the establishment of a solid foundation of the subject. The history of the development of the theory of ordinary complex numbers furnishes many instances of such forward steps. There is, however, no satisfactory evidence now extant for the assertion that "as early as the fifteenth century mathematicians were compelled to introduce symbols for the square roots of negative numbers in order to solve all quadratic and cubic equations." This assertion appears on page 92 of the valuable volume entitled "What is Mathematics?" by Richard Courant and Herbert Robbins (1941).

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WHEAT GRAINS WITHOUT EMBRYOS[1]

A CRITICAL examination of several thousands of wheat grains of the 1941 crop for separation of kernels only slightly affected by sprout injury showed occasional grains which had a slightly concave area where the embryo usually produces a convex area. This at once suggested the embryoless seeds described by Lyon.[2] Some of the grains were sent to Dr. George H. Conant for sectioning, and these sections show clearly the embryoless condition.

Miss Lyon was especially interested in studying the respiratory activity of such seeds because previous comparisons of activity of embryo and endosperm had been made from samples from which embryos had been removed. She did not discuss the origin of embryoless seeds. Her work was the first report of this condition in wheat. Harlan and Pope[3] had reported the first case in cereals, finding five such seeds in many thousands of barley. They suggested that either the fertilization from which the embryo is formed had failed to occur or that development had been arrested shortly afterward, since there was not more than a doubtful trace of embryo cells.

Miss Lyon found that such seeds were not infrequent in wheat, finding about 0.1 per cent. in 150,000 grains, using six different varieties representing both winter and spring wheats. The North Dakota material examined was chiefly one sample of Ceres, a hard red spring wheat developed at the North Dakota station, and the proportion was similar to that found by Miss Lyon. This adds another variety to the list and supports her conclusion that it is not an uncommon occurrence.

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SCIENTIFIC BOOKS

VERTEBRATE EMBRYOLOGY

Introduction to Vertebrate Embryology. By WALDO SHUMWAY. Fourth edition. 372 pp. New York: John Wiley and Sons. 1942. $4.00.

THIS text, having reached the fourth edition, has quite evidently established itself. The present issue is considerably altered, but retains the general method of comparative treatment, *i.e.,* each of the four animals, amphioxus, frog, chick and man, is compared in its development in each system or part. Physiology is also stressed as formerly. The changes relate principally to increased attention to organogeny, to de-

[1] Contribution from the N. D. Agricultural Experiment Station. Published with the approval of the director.
[2] Mildred E. Lyon, *Jour. Agr. Res.,* 36: 631–637, 1928.
[3] H. V. Harlan and M. N. Pope, *Am. Jour. Bot.,* 12: 50–53, 1925.

creased space given to genes and chromosomes, and to condensation of the material dealing with the anatomy of vertebrate embryos into an atlas. Much of the book has been rewritten, partly in an effort to include recent work. The illustrations are numerous and clear, but sometimes rough. There are nineteen chapters, including one on embryological technique, a glossary and twenty pages of index. The book is clearly the outgrowth of much use, and represents a practical adaptation of this experience.

Fundamentals of Comparative Embryology of the Vertebrates. By ALFRED F. HUETTNER. 416 pp. New York: The Macmillan Company. 1941. $4.50.

HERE is another book which has grown out of the experience of the author, more than half of the many excellent figures having come from his own hand. This is an important matter in this case, because they furnish the foundation of the entire work and are beautifully prepared. There are again nineteen chapters, but this time, after four chapters dealing with protoplasm and the cell, development of sex, chromosomes in development, gametes and fertilization, these take up in turn amphioxus, 1 chapter; frog, 3 chapters; chick, 7 chapters; and mammals, 4 chapters. There is thus quite a contrast in the general treatment, as compared with Shumway, and an evident lack of continuity in the account of the different systems. Another instance of similarity in the two books is the use of the same four animals for study.

One would expect accuracy in the treatment of general topics, such as the chromosomes, but does not always find it. Thus in discussing the process of mitosis it is stated that "Mitosis is initiated in the nucleus by the precipitation of chromatin granules and fibers which form an entangled thread-like structure called the *spireme*. . . . These are the chromosomes, their shape being constant from one cell generation to the next in spite of the fact that they disintegrate in the interphase nucleus and are built up from it again in the next mitosis." This gives a very faulty interpretation of the process, for, instead of disintegrating and reforming, they preserve their form by a continuous existence, which is the essence of their being. The number of chromosomes for Anasa is stated to be twenty-two, without indication that that is the female number. In describing the history of the X-chromosome in the grasshopper it is stated to divide in the first spermatocyte, instead of in the second. Such errors as these are unfortunate, but do not affect the general character of the book, which is excellent.

A Manual of Experimental Embryology. By VIKTOR HAMBURGER. 213 pp. University of Chicago Press. 1942. $2.50.

HERE is a book quite different from the preceding two. Its approach is experimental and it details the requirements which this method calls for, including instruments and equipment, Part I. Part II deals with experiments on amphibian embryos. Here we find a discussion of living material, including breeding habits, rates of development, culture media and rearing and feeding larvae. Under experiments there are sections devoted to technical procedures, embryonic areas, pregastrulation stages, transplantation methods, morphological fields, embryonic induction, parabiosis, external factors in development and the development of behavior patterns. Part III concerns itself with the chick embryo, and under the heading "Material and technical procedures" treats incubation, limb bud stages, equipment for operations and staining cartilage *in toto*. The experimental technique here deals with vital staining, chorio-allantoic grafts and intraembryonic transplantations. Part IV takes up regeneration experiments upon Planaria and amphibian larvae, producing the various two-headed and two-tailed larvae, tail regeneration, limb regeneration and lens regeneration effects. Finally in Part V there is a special treatment of the gradient theory of Child, with experiments on Planaria and chick embryos. For each section there is a bibliography, which deals only with the subject-matter treated. It is the opinion of the author that "a course in an experimental branch of biology not only should acquaint the student with new facts but should strengthen his power of reasoning and his logical acuity as well." The experiments outlined are all simple and do not demand any unusual apparatus or special installation. They are all routine class exercises, and none of them require the use of sections for their study. Furthermore they are so planned and stated that they may be taken up in any convenient order at the desire of the teacher. This book is sure to be a successful addition to the series of worthwhile American texts on embryology.

C. E. MCCLUNG

MATHEMATICS

Calculus. By G. E. F. SHERWOOD and ANGUS E. TAYLOR. xiv + 503 pp. New York: Prentice-Hall, Inc. 1942. $3.75.

"CALCULUS" sets a new high standard for text-books for the first course in differential and integral calculus. The topics treated and the order in which they are presented are those which have become largely standard in American texts: differentiation, with the usual applications, comes first; later, integration with geometric and physical applications; finally, partial differentiation, hyperbolic functions, multiple integrals and infinite series. The unique features of the book are to be found in the treatment of the material:

fundamental concepts are emphasized; definitions, especially those of function, limit and integral, are modern and precise; more theorems are proved than usual, and the proofs given are correct.

The definition of function, which differs from that still found in many texts, and the ε, δ definition of limit are given in the first chapter. The treatment of limits distinguishes and includes limits of sequences and of functions of a continuous variable; the fundamental theorems on limits are stated and proved by ε, δ methods. The Cauchy condition is taken as fundamental in the treatment of limits of sequences; it is proved that a bounded monotonic sequence has a limit.

A correct proof is given for the formula for the derivative of a composite function (the customary proof in American text-books is simple and suggestive, but unfortunately it is not correct). It is proved that if a function has a derivative at a relative maximum or minimum, this derivative is zero (a beginning text usually bases this result on intuition). The definite integral is introduced before the indefinite; it is proved, using the Cauchy condition for the limit of a sequence, that a continuous function has a definite integral. It is stated, though not proved, that a function which is continuous on a closed interval is uniformly continuous. Duhamel's Principle is stated and proved and used systematically in setting up the integrals that occur in the geometrical and physical applications. The treatment of partial differentiation, which includes Jacobians and applications to curves and surfaces, is preceded by a chapter which gives a brief but adequate treatment of analytic geometry of three dimensions.

It may perhaps appear from this account that the book is a mathematical treatise and not a text for beginners, but such is not the case. It is undoubtedly true that the book will be most appreciated by good students, but rigor and precision have not been made stumbling blocks. Intuition has not been replaced by mathematical rigor; rather there is a happy blending of the two with each reinforcing the other. The treatment is fresh and lively; the exposition proceeds with ease and assurance.

Finally, it is in order to record the passing of the infinitesimal; the term itself does not occur in the index. The book is calculus, not infinitesimal calculus. Infinitesimals, meaning something "infinitely small," were introduced into calculus by Leibniz, and the fact that the subject was based on something mystical, unproven and lacking reality did much to hinder its early understanding and acceptance. Klein has pointed out that these "infinitely small" quantities persisted in texts even into the twentieth century in a country so mathematically advanced as Germany. Beginning with Cauchy, "infinitesimal" has more often meant something which becomes infinitely small, but even in this sense the concept has lost favor with mathematicians. At the present time calculus is based solidly on the notion of limit; at last we have a beginning text that eliminates infinitesimals entirely and enlarges the treatment of limits.

The Gist of Mathematics. By JUSTIN H. MOORE and JULIO A. MIRA. xii + 726 pp. New York: Prentice-Hall, Inc. 1942. Trade, $5.35; school, $4.00.

"THE GIST OF MATHEMATICS" is a text-book for a survey course. There are fairly complete treatments of elementary algebra, plane geometry and solid geometry, partial accounts of plane analytic geometry and plane trigonometry, and a brief introduction to differential calculus. The book was written to teach mathematics, but the emphasis is on elementary concepts, the facts and their applications rather than on logical development and mathematical completeness. Each chapter closes with a set of exercises. Also, there are 105 pages of additional exercises and problems at the end of the book; they are grouped according to the chapters of the book, and there are precise references to relevant pages of the text. The problems will appeal to the student as modern and practical. No answers are given. Three appendices explain the method of extracting square root, list the Greek alphabet, the symbols used, mensuration formulas and facts regarding spatial relationships (plane and solid geometry theorems from the text). There is a brief set of tables in a pocket inside the back cover. A detailed index of 16 pages enhances the book's value as a reference work. The book is attractively printed; there are many figures, pen drawings, reproductions of old prints and woodcuts and photographs. The attention paid to mensuration formulas, the theorems of plane and solid geometry, and systems of weights and measures, including tables of equivalents for different systems, serve to emphasize the authors' interest in the usefulness and applications of mathematics; in the preface they refer to the needs of accountants, economists, biologists and scientific workers in all fields.

This book should be a useful text for a course in which the students have not had much previous training in mathematics, and in which the emphasis is on applications of a practical and everyday nature. The mathematics courses in a good high school cover nearly all the material in the book. Judged by standard college courses, it is elementary, all-inclusive and yet incomplete. For example, it includes six subjects, but in trigonometry the treatment of the solution of triangles is incomplete, and there is hardly any mention of trigonometric identities. Thus, it is a well-written book designed for a survey course.

Mathematics in Human Affairs. By FRANKLIN WESLEY KOKOMOOR. xi + 754 pp. New York: Prentice-Hall, Inc. 1942. Trade, $5.35; school, $4.00.

"MATHEMATICS IN HUMAN AFFAIRS" is undoubtedly intended as a text for a course in college mathematics which has been given with increasing frequency in recent years: a course which is cultural in nature and terminal in character—does not prepare the student for the usual trigonometry-analytic geometry-calculus sequence; the author states that it was written for "the reader of average ability with almost no previous preparation." For such a course Professor Kokomoor has written a text of unusual excellence.

"Mathematics in Human Affairs" covers practically the entire field of elementary mathematics: it begins with the simplest concepts and ends in the calculus. There are chapters on statistics, probability, mathematics of finance and geometric constructions as well as the more usual topics of algebra, trigonometry, analytic geometry and calculus. The book has the informal character of the lecture room; it is discursive and entertaining. Most of the chapters can be read independently of the others. On almost every page one finds new and interesting bits of history of mathematics, of mathematicians and of civilization in general; explanations of the origins and meanings of words; discussions of economics, philosophy and sociology; indications of the applications of mathematics; elegant solutions of certain problems not treated in the usual elementary courses; illustrative anecdotes that enliven the account; and mathematical figures, pen drawings and reproductions of old prints. It was the author's intention to show that mathematics has been one of the component parts of civilization throughout its history, and he has succeeded well.

But just because mathematics is playing such an important rôle at present in the lives of Americans, this book will probably have few readers. It can not be considered a satisfactory text for the development of those mathematical techniques needed in science, industry and the armed services (it was not intended to be such), and no young man of college age now has the leisure to study any other kind of mathematics book.

Furthermore, as a result of his decision to treat only elementary matters, Professor Kokomoor tells only part of the story of mathematics in human affairs—the part which deals with mathematics in the past: "But after all, the major portion of what we have considered is old, its age running for several centuries to several thousands of years." Mathematics is not portrayed as one of the all-important tools in the construction of the *modern* world. No stratosphere aeroplanes fly across the pages of this book, and no mention is made of the part mathematics plays in their construction and navigation.

Books on physics, chemistry, engineering and medicine for the general public contrast sharply with those on mathematics: the former tell of the wonders that are being accomplished to-day and the new world that will be built to-morrow; the latter usually tell of the subject's long and dignified past. The public, well informed about progress in other sciences, still does not know of the part applied mathematics is playing in building the new world, nor of recent brilliant results in pure mathematics such as the proof of the Ergodic Theorem, the proof of Waring's Theorem and the solution of the Problem of Plateau.

Our mathematical unpreparedness at the outbreak of the present war was one result of the public's lack of information about the subject. Although research in pure mathematics had been advancing rapidly, there were no centers for research in applied mathematics or the training of applied mathematicians for industry. Furthermore, mathematics no longer held the position of honor, nor even one of high esteem, in a liberal education; industry and the armed services were impeded because so many lacked a knowledge of even the elements of mathematics. The recent list compiled by Professor Dresden indicates to what extent America's leading position in mathematical research may have been attained by importing scholars from Europe.

The wonder books and popular expositions of science serve a useful purpose. Hermite said, "Abel has left mathematicians enough to keep them busy for five hundred years." Asked how he had accomplished so much in the six or seven years of his working life, Abel replied, "By studying the masters, not the pupils." But we are apt to overlook the sources of the initial inspiration to study the masters. Charles Darwin has recorded that Humboldt's "Personal Narrative" and Herschel's "Preliminary Discourse on the Study of Natural Philosophy," two of the leading books of popular science of his day, "stirred up in me a burning zeal to add even the most humble contribution to the noble structure of Natural Science. No one or a dozen books influenced me nearly so much as these two." Napoleon I wrote, "The advancement and perfection of mathematics are intimately connected with the prosperity of the state." Napoleon as a patron was sufficient, but in a democracy mathematics will attract able students and win support only from an informed public.

It is to be hoped that Professor Kokomoor or another will write the other volume on mathematics in human affairs—the story of the wonders of the present and the future.

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REPORTS

ABSTRACT OF A PLAN FOR COLLABORATION[1] BETWEEN COLLEGES AND UNIVERSITIES AND THE DEPARTMENT OF AGRICULTURE WITH SPECIAL REFERENCE TO TRAINING REPLACEMENTS DURING THE WAR

I. *The Problem*

THE war has made necessary many readjustments in recruiting, employing and training people for Government Service. The problem of continuing to operate effectively with fewer and less qualified personnel, and in many cases, with expanded and new agency functions, confronts every bureau and office in the department. The successful prosecution of the war and adequate maintenance of the essential functions of the Department of Agriculture depend upon trained personnel. As is the case with other agencies of Government, the department faces a serious shortage of trained workers. From the experienced personnel, the various bureaus of the department have contributed heavily to the armed forces and to other agencies. For the fiscal year 1942, the department experienced personnel separations numbering approximately 28,000 or 35.6 per cent. In contrast, for the period from 1935 through 1940, the Department of Agriculture had experienced personnel separations of about 10 per cent. each year, resulting in 6,000 to 8,000 new employees annually. How critical the shortage of personnel will become during the present emergency no one can predict.

The department normally employs large numbers of college-trained people. As of June, 1940, 41 per cent. of the employees in the department were college graduates. An additional 23 per cent. attended college, but did not graduate. Thus, approximately two thirds of the employees, as of June, 1940, had had educational experience in colleges and universities.

Work pertaining to the war effort must be done quickly and effectively, hence personnel must be recruited and trained quickly. Training is basic to the department's war strategy. And training itself must be geared to wartime conditions; it must be as up-to-the-minute as the latest airplane or gun. Some of this training can be and is being done after the new employee is on the job. However, it is recognized that pre-service training would reduce materially our recruitment and training problems and would increase the efficiency of those units having vacancies.

We are fully aware that colleges and universities already have made major readjustments to meet the war emergency. The problem before us then resolves itself into: What further can such educational institutions do, for the duration of the war, to help train personnel for positions in the Department of Agriculture.

II. *Developments Leading to Plan for Collaboration between Colleges and Universities and the Department of Agriculture*

Since 1936, the Land-Grant College Department Committee for Training for Government Service has been active in developing means of collaboration between colleges and universities and the Department of Agriculture. In recent months, the Department Committee has worked on the development of a plan for recruiting and training replacements for technical and professional positions in the Department of Agriculture during the war emergency, with special reference to the part which colleges might do. A number of bureaus of the department have been cooperating with colleges and universities for several years in training, recruiting and employing personnel. Such bureaus include Office of Experiment Stations, Forest Service, Bureau of Plant Industry, Bureau of Entomology and Plant Quarantine, Farm Security Administration, Bureau of Animal Industry, Soil Conservation Service, and Extension Service. Due to the emergency, we are now faced with the necessity of increasing emphasis on the type of training which will materially facilitate the task of getting the job done.

The committee developed the current report with the hope that maximum use may be made of the facilities of educational institutions in meeting the increasing need for trained personnel of the department during the emergency, looking forward also to the needs which will have to be met following the war.

III. *Opportunities for Collaboration between Colleges and Universities and the Department of Agriculture*

It is recognized that colleges and universities are encountering increasing difficulties with respect to losses in instructional staff. At the same time, they have been assigned additional specific responsibilities by the Army and Navy for training for the armed services. It may well be that arrangements can be made for further cooperation between the colleges and the Department of Agriculture to their mutual benefit. Such cooperation may be promoted through (1) redirecting emphasis of present courses for regularly enrolled students; (2) initiating special courses to meet specific needs of (a) women, (b) the physically handicapped and (c) older men not subject to Selective Service.

IV. *Organization for Facilitating Collaboration*

This plan anticipates mutual benefits. *First,* the

[1] Prepared by Department Section of the Land-Grant College Department Committee on Training for Government Service, October 24, 1942.

colleges and universities may thereby develop a more complete understanding of the organization, policy and activities of the Department of Agriculture, which in turn reflect the type of persons needed. *Second,* the Department of Agriculture may develop a better understanding of the problems confronting colleges and universities in training and placement.

The Department of Agriculture could arrange to send regularly to the colleges and universities current information on the department's program with respect to: (1) organization, policy, and activities of the department; (2) positions to be filled in the department including replacements; (3) educational requirements for such positions; (4) specific information regarding basic training needed; and (5) opportunities for service and permanent careers in USDA.

Colleges and universities may want to make use of information thus provided: (1) in college freshman orientation programs; (2) in college counseling programs; (3) in plans for placement; and (4) in the redirection of emphasis of course content to meet the needs of those students anticipating a career with the Department of Agriculture.

V. *Suggested Procedure for Analysis and Treatment of Wartime Training Needs*

An outline of approach for determining training needs for personnel replacement in time of war and effective methods of meeting these needs is given in the full report "A Plan for Collaboration between Colleges and Universities and the Department of Agriculture with Special Reference to Training Replacements during the War," of which this is an abstract.

It is there set forth that the Department of Agriculture: (1) determine personnel needs by jobs; (2) analyze the job to be done; (3) determine the source of replacements; (4) determine qualifications of replacements; (5) determine differential in training needed by replacements; (6) determine where such training can best be given; (7) determine that part of training which colleges could perform; (8) furnish colleges with detailed information concerning specific training needed.

To illustrate how this formula can be applied to any personnel situation, the cases of the AAA County Administrative Officer (Appendix C) and Assistant Scientific Aid (Appendix D) are explained in detail in the full report.

If it is found that a plan such as the one given is practical and feasible, the colleges and the Department of Agriculture should work out essential administrative details and proceed as soon as possible to develop the best methods and procedures for getting the job done.

The Department of Agriculture can not afford to be hampered by lack of trained personnel in this emergency. It is essential that our allies, our men in the armed forces and our civilian population may continue to eat.

SPECIAL ARTICLES

CAROTENE. I. PRELIMINARY REPORT ON DIPHENYLAMINE AS A STABILIZER FOR CAROTENE

CERTAIN commercial feed preparations for poultry and animals have been fortified with fish liver oils to supply vitamin A needed for improved growth and higher vitality. The present scarcity and increased prices may limit the use of such oils as feed supplements. Carotene, a precursor of vitamin A, is plentiful in green and yellow plant material and may be extracted and used to replace fish liver oils in food and feed preparations.

Carotene, being an unsaturated compound, is very readily oxidized, thereby losing its provitamin A value. The prevention of this oxidation is an important problem in the use of carotene as a vitamin A supplement for feeds.

It has been shown by Fraps and Kemmerer[1] that certain feeds fortified with carotene may lose as much as 70 per cent. of their carotene content in 16 weeks of storage at 28° C. These men also showed that fish liver oils added to feeds lost 79 to 100 per cent. of their vitamin A potency after four weeks' storage at either 7° C. or 28° C. Mitchell and Lease[2] have decreased the loss of carotene in dried powdered sweet potatoes by adding 10 per cent. of crude cottonseed oil. However, when stored at 37° C. the material so treated showed a rapid loss of carotene after 90 days and soon contained less than the untreated material.

A preliminary investigation has been made to determine the stabilizing effect of about 100 substances of antioxidant character on carotene. In these tests it was found that diphenylamine had the greatest stabilizing effect. More extensive tests are being made on these substances, especially diphenylamine.

Diphenylamine has been used as a stabilizer in cellulose nitrate[3] and soap[4] but has not been used in food

[1] G. S. Fraps and A. R. Kemmerer, Texas Agr. Expt. Sta. Bull. 557, 1937.

[2] J. H. Mitchell and E. J. Lease, South Carolina Agr. Expt. Sta. Bull. 333, 1941.

[3] W. W. Bradley, *U. S. N. Inst. Proc.*, 41: 125–9, 1915.

[4] R. E. Divine, U. S. Patent No. 1,542,438, June 16, 1925.

or feed. Its physiological effects are not well known. Reports show that rabbits usually recover from single doses of 0.5 to 1.5 gm per kilogram of body weight[5] and that doses of 3–10 grams given to dogs as an anthelmintic produced no symptoms of intoxication which could be attributed to the effect of the treatment.[6] This is over 1,000 times the amount needed to stabilize the animal's daily need of carotene. Biological tests are being initiated in this laboratory to determine whether small daily doses of diphenylamine have any deleterious effects upon the animal and also to determine whether this compound interferes with the animal's ability to utilize carotene.

The mixtures used in our experiments were made by adding carotene,[7] white mineral oil and stabilizer to oil-free rice bran. The mixtures were formed into pellets to reduce the surface exposed directly to air. The mineral oil was used to fill pore space and thereby cut down the diffusion of air into the pellets. Solutions of carotene in edible oils and in organic solvents to which stabilizers have been added are also under investigation.

It is known from published data that mineral oil interferes with the utilization of carotene, even when ingested in small amounts.[8] Nevertheless, mineral oil was used in order to avoid the interference of peroxide and acid formed in edible oils by oxidation so that the direct effect of antioxidants on carotene could be observed. Antioxidants and conditions found to be effective for stabilizing carotene in mineral oil will also be applied to carotene in edible oils. Preliminary tests using edible oil show a similar preservation of carotene by antioxidants.

Some of the pellets were analyzed directly after preparation. Other pellets were stored in darkness at 37° C., but freely exposed to air, for 30 days before analysis. The analysis was made by dissolving the carotene from a weighed pellet with petroleum ether, b.p. 30°–60° C. The carotene dissolved in a very few minutes and the solution was then passed through a column of dicalcium phosphate[9] covered with anhydrous sodium sulfate. The resulting clear solution was diluted to a suitable volume and its light transmission was measured with an Evelyn photoelectric colorimeter using a 420 mμ filter. The carotene concentration was determined by comparing the reading with a previously constructed transmission-concentration curve. Subsequent tests have shown that mineral oil interferes to a certain extent with the removal of oxidized products of carotene by the dicalcium phosphate, and for this reason the values reported in Table I are a little high.

The addition of diphenylamine to the mixtures caused a marked increase in the per cent. of carotene retained after storage (Table I). Two samples containing diphenylamine (Nos. 8 and 10) retained 96 and 97 per cent. of the original carotene after 30 days of storage, whereas similar samples without diphenylamine (Nos. 7 and 9) retained only 58 and 68 per cent., respectively, of their original carotene after similar storage.

TABLE I

THE STABILITY OF CAROTENE ADDED TO MIXTURES OF RICE BRAN AND MINERAL OIL

Sample No.	Ratio of white mineral oil to rice bran*	Antioxidant used†	Carotene before storage	Carotene after 30 days storage at 37° C.	Per cent. carotene retained
			Mg/gm	Mg/gm	%
1	None	None	0.63	0.06	10
2	1 : 10	None	0.64	0.17	27
3	1 : 10	Diphenylamine	0.68	0.53	78
4	1 : 5	None	0.60	0.31	52
5	1 : 5	Diphenylamine	0.64	0.57	88
6	1 : 5	Hydroquinone	0.64	0.50	78
7	1 : 4	None	0.66	0.38	58
8	1 : 4	Diphenylamine	0.67	0.65	96
9	1 : 2.5	None	0.66	0.45	68
10	1 : 2.5	Diphenylamine	0.66	0.64	97

* The rice bran used in these experiments was extracted with petroleum ether until free of oil.

† In all cases 5 mg of antioxidant were incorporated in each gram of mixture.

Hydroquinone, which has been recommended as a stabilizing agent for carotene in synthetic solvents,[10] was also used in these experiments. A comparison of results for samples 4, 5 and 6 (Table I) shows that the pellets containing diphenylamine retained 88 per cent. of the carotene after storage, the pellets containing hydroquinone retained 78 per cent. and those containing no antioxidant retained only 52 per cent. Similar results have been obtained in many other tests, not reported here.

There was a marked difference in the retention of carotene when various ratios of white mineral oil to rice bran were used in the mixtures. It may be noted, however, that an oil-bran ratio of 1:4 is as satisfactory as a ratio of 1:2.5 in the retention of carotene when diphenylamine is present. In the absence of diphenylamine, however, this same increase in oil content of the preparation does show an increase of carotene retention (see Nos. 7 and 9, Table 1).

It must be known from adequate tests that a sub-

[5] P. Lande, P. Derville and R. Colloft, *Comp. Rend. Soc. Biol.*, 117: 363–5, 1934.

[6] James E. Guthrie, *Proc. Helminthol. Soc. Washington*, December 7, 1940, pp. 84–5.

[7] Carotene is used herein to denote a mixture of approximately 90 parts beta- to 10 parts alpha-carotene.

[8] R. Adams Dutcher, Philip L. Harris, Eva R. Hartzler and N. B. Guerrant, *Jour. Nutrition*, 8: 269–83, 1934.

[9] L. A. Moore, *Ind. Eng. Chem., Anal. Ed.*, 12: 726–8, 1940.

[10] H. S. Olcovich and H. A. Mattill, *Jour. Biol. Chem.*, 91: 105–117, 1931.

stance is harmless when ingested by animals before it can be used in food or feed. Since such information is not yet available for diphenylamine, it is not safe to make any practical application of the results of this study.

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EDEMA IN VITAMIN E DEFICIENT CHICKS[1]

INCREASING the concentration of soluble salts in the diet has been stated by Dam and Glavind[2] to be an effective means of increasing the severity of the edema which develops in chicks fed a diet low in vitamin E. Experimental results confirming this statement have been obtained in this laboratory and were reported at the Ninth Informal Poultry Nutrition Conference held in Boston on March 31, 1942. For example, in one experiment 100 per cent. mortality resulted in a group of 9 three-week-old chicks given daily doses of NaCl solution (20 gms/100 ml) during a six-day period. Eight of the 9 chicks showed some form of edema. One of 8 control chicks given no NaCl died during the same period but showed no evidence of edema. The group given NaCl solution received 0.017 ml/gm body weight on the first day of treatment and the dose was gradually increased, reaching 0.021 ml/gm body weight on the sixth day. All chicks were fed a vitamin E-low diet consisting of dextrinized corn starch 59, dried skimmilk 20, casein 13, butyl fermentation residue 3, oyster shell flour 1, calcium phosphate 2, sodium chloride 1 and cod liver oil 1. To each kg were added 120 mg $MnSO_4 \cdot 4H_2O$, 2 mg thiamine, 2 mg 2 methyl 1–4 naphthoquinone and 1 gm choline hydrochloride.

Administration of NaCl solution was first tried because chicks fed diets similar to that given above did not develop edema as readily as did chicks fed the diet previously described,[3] which contained 54 per cent. of dried skimmilk. It appears that disturbance of the osmotic equilibrium is necessary in addition to vitamin E deficiency to cause generalized edema.

Supplementation of the diet outlined above with 20 per cent. of a practical chick mash protected chicks against edema even when NaCl solution was administered. Lower levels of the practical mash were not effective. These results were interpreted as an indication of the vitamin E content of this mash, but some doubt is cast on this interpretation by the report of Dam and Glavind that inositol and lipocaic also protect against edema.

Experiments in this laboratory on the specificity of the protective effect of vitamin E were directed toward compounds having similar antioxidant properties. Toluhydroquinone, p-xyloquinone and trimethyl hydroquinone were inactive when fed at four times the effective level of alpha tocopherol. They are also ineffective when fed to rats.[4] Beta tocopherol[5] was about half as potent as alpha tocopherol, and this also conforms to the results of rat experiments.[6]

Pappenheimer, *et al.*,[7] in their extensive studies on encephalomalacia in chicks showed that the primary changes in this manifestation of vitamin E deficiency were edema and hemorrhage resulting from alteration of the capillary walls in the brain. It now appears that such alteration occurs in other parts of the vitamin E deficient organism but is not usually sufficient to permit exudation unless the normal osmotic relationships are disturbed. The question may well be raised as to the possible relationship of capillary changes to the various manifestations of vitamin E deficiency in other species.

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ISOMORPHISM AND ISOTYPISM AMONG SILICATES AND PHOSPHATES

RECENT advances in the study of isomorphism and isotypism may be illustrated through examples taken from compounds related to two mineral groups, the garnets and the apatites. Investigations by numerous chemists and mineralogists have revealed new isomorphic and isotypic relationships among silicates and phosphates, such as the isotypism of $AlPO_4$ and SiO_2 reported by Huttenlocher. However, a complete discussion is beyond the scope of these brief comments and complete references to the diverse sources of the data are purposely omitted.

Isomorphism, in the sense of the mineralogist, is characteristic of those compounds which exhibit stereochemical miscibility (so-called mixed crystals). Limited isomorphism obtains when the stereochemical miscibility is limited, whereas complete isomorphism exists when numerous intermediate members have been proven.

[1] Scientific paper No. A36a, Contribution No. 1857 of the Maryland Agricultural Experiment Station (Department of Poultry Husbandry).

[2] H. Dam and J. Glavind, SCIENCE, 96: 235, 1942.

[3] H. R. Bird and T. G. Culton, *Proc. Soc. Exp. Biol. and Med.*, 44: 543, 1940.

[4] C. Golumbic and H. A. Mattill, *Jour. Biol. Chem.*, 134: 535, 1940.

[5] Alpha and beta tocopherol and trimethyl-hydroquinone were furnished by Merck & Co., Inc., Rahway, N. J., through the courtesy of Dr. D. F. Green.

[6] P. Karrer and H. Fritzsche, *Helv. Chim. Acta*, 22: 260, 1939.

[7] A. M. Pappenheimer, M. Goettsch and E. Jungherr, *Conn. Agr. Exp. Sta. Bul.*, 229, 1939.

Isotypism overlaps to some extent the chemist's concept of isomorphism; it denotes compounds of equivalent structural types. Nevertheless, it is apparent that ionic substitution of the isomorphic sort is not a part of the connotation of isotypism. Actually the distinction between isomorphism and isotypism is somewhat arbitrary because it depends upon our knowledge of the mutual relationships of the compounds. Although miscibility among several isolated compounds may be unknown at present, the existence of one or more intermediate members, and hence limited or complete isomorphism, may be demonstrated at a later date.

Elementary texts on mineralogy may show the composition of garnets as $R''_3R'''_2(SiO_4)_3$, suggesting within this group the isomorphism which is well known. However, a more complex type formula is necessary to cover the phosphates, arsenates and hydrates which are now recognized as isotypes. These are:

$Ca_3Al_2(OH)_{12}$
$Ca_3Fe_2(OH)_{12}$
$Ca_3Al_2(SiO_4)_2(OH)_4$ (Pabst)
$Na_3Al_2(PO_4)_3$ (Thilo)
$(Ca_2Na)Mg_2(PO_4)_3$ (idem.)
$[Na(Ca,Fe)Al]Mn_2[(PO_4)_{2.5}(OH)_2]$ (McConnell)
$(Ca_2Na)Mg_2(AsO_4)_3$ (Bubeck & Machatschki)
$(Ca_2Na)Mn_2(AsO_4)_3$ (idem.)

These garnetoids have the type formula $X_3Y_2(ZO_4)_{3-m}(OH)_{4m}$, all are cubic and, with one probable exception, all have the space group of the common garnets (anhydrous silicates).

Isomorphism has not been demonstrated among these compounds except for the first three (Flint, McMurdie and Wells) and the last pair. However, P_2O_5 has very recently been found to the extent of about four per cent. (Mason and Berggren) as a constituent of a silicate garnet, demonstrating at least limited isomorphism of spessartite and a phosphate garnetoid. Replacements of R″ of the simple textbook formula are not necessarily bivalent elements, nor are the replacements of R''' necessarily trivalents, although these valence conditions are almost universally fulfilled among the common garnets.

Turning to the apatites, the examples become even more complex but, again, a general formula may be devised: $X_{10}(F,OH,Cl)_2(ZO_4)_6$, where X is usually Ca or Pb, and Z is P, As or V. These compounds have been known for many years and will not be discussed. Several isotypes have been described recently and some of these are of considerable interest. They are:

$(Ce_{5.5}Ca_{3.5}Na)(OH,F)_2[(SiO_4)_{4.5}(PO_4)_{1.5}]$
(Hägele & Machatschki)
$(Na_6Ca_4)F_2(SO_4)_6$ (Klement & Dihn)
$Ca_{10}(OH,Cl,F)_2[(SiO_4)_3(SO_4)_3]$ (McConnell)

The last of these seems to form a complete isomorphous series with the corresponding phosphate compound, $Ca_{10}(F,OH,Cl)_2(PO_4)_6$.

Another very interesting feature of the isomorphism of apatite is the limited substitution of C for P, together with the suggested substitution of C for Ca. The isotypic carbon compounds, however, have not been discovered and probably do not exist. A more or less complete list of the substitutions, then, is:

X ≏ Ca, Mn, Sr, Na, K, Ce, and, in lesser amounts, Y, La, Th, Ta, Fe, Al, Mg, and C (?).
Z ≏ P, As, V, S, Si, Cr, and C.

Some of these are strange bedfellows indeed.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DEVICE FOR CALIBRATING SMALL AIR PUMPS

To measure the concentration of moisture in the air at two or more levels, in connection with the development of a method for determining the rate of evaporation from land surfaces,[1] a chemical absorption hygrometer satisfactory for field use was devised.[2] An essential element of the hygrometer is a reciprocating pump of approximately 5 cc capacity per stroke, which for satisfactory operation must be accurately calibrated. Since the device that was developed for making the calibration may have other laboratory uses, it is described in the following note.

The essential operation of the device is replacing an unknown volume of air with an equal volume of water, the transfer taking place at atmospheric pressure and measuring this volume of water.

In Fig. 1, a diagram of the device (a) represents a liter flask in which water replaces a volume of air to be measured. The flask has a drain valve (b) in the bottom and a graduated glass stem (c) in the top. In the upper end of the stem is a three-position valve (d) through which flask (a) is opened or closed to the atmosphere or connected to the intake of an air pump. The stem is enlarged below valve (d) to enclose a spout (e) which is a water passage from reservoir (f) to flask (a). A glass tube (g), opened

[1] C. W. Thornthwaite and Benjamin Holzman, *U. S. D. A. Tech. Bull.* No. 808, May, 1942.

[2] C. W. Thornthwaite, *Trans. Amer. Geophys. Union*, pp. 429–432, 1941.

to atmospheric pressure, extends into reservoir (f) and the tube is adjusted so that its lower end will be at the level of spout (e). The operation of the device depends on this adjustment. Valve (h) releases air trapped when filling reservoir (f) with water.

The intake of an air pump to be calibrated is connected to valve (d) and this valve closed to the pump and atmosphere. Valve (b) is closed and valve (h) opened. Reservoir (f) is then filled with water through tube (g). As reservoir (f) is being filled an amount of water will flow through spout (e) into

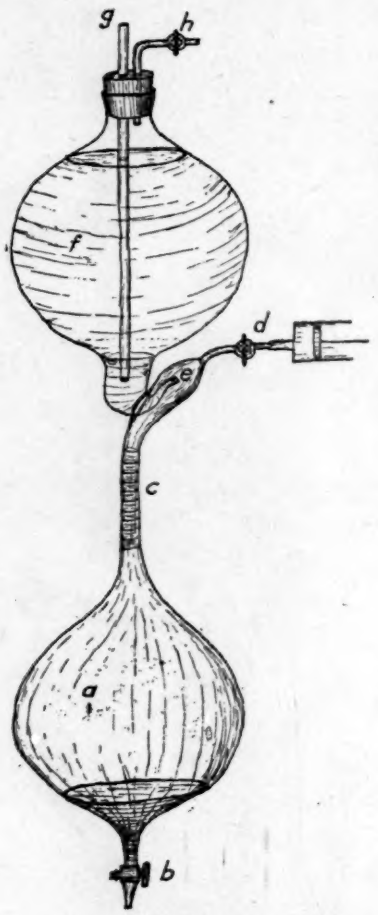

FIG. 1.

flask (a) which maintains air pressure in flask (a) equal to the head of water above spout (e). When reservoir (f) is full valve (h) is closed and the three position valve (d) opened to the atmosphere. Releasing the air pressure in flask (a) causes pressure readjustments in reservoir (f) and sufficient water will drain from the reservoir to establish less than atmospheric pressure above the water in the reservoir and atmospheric pressure at the surface of the water in spout (e) and the end of tube (g). The excess water in flask (a) is drained to a zero mark on the stem of valve (b). Valve (d) is closed to the atmosphere and opened to the pump. The apparatus is now ready for a pump calibration.

As the pump exhausts air from flask (a) the pressure in flask (a) tends to decrease, but a spontaneous adjustment of pressures in the system takes place which maintains atmospheric pressure in flask (a). The process of adjustment is: decreasing pressure on the surface of the water in spout (e) forces water from reservoir (f) into flask (a) until the pressure in flask (a) is brought back to atmospheric pressure. At the same time water flowing from reservoir (f) decreases the water pressure in reservoir (f) and air will be forced into reservoir (f) through tube (g) until atmospheric pressure is again reached in the water at the level of spout (e). Thus the device maintains atmospheric pressure in the flask (a) and any volume of air pumped from this flask will be replaced by an equal volume of water.

For a calibration the pump is run until the water flowing into flask (a) has reached the graduations on stem (c), from which its volume can be determined. This volume divided by the number of strokes made by the pump during the operation gives the volume per stroke of the pump.

The pressure of the air enclosed in the system is affected by any temperature change, and any variation in this pressure affects the accuracy of the device. To eliminate this source of error all parts of the system should be at a uniform temperature, and as the enclosed air responds more rapidly to temperature changes than the water the temperature range, during a run, should be kept to a minimum. Another source of error is incomplete water drainage from flask (a) between runs. This can be avoided by keeping the glass chemically clean.

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